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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	William L. Puskas
Serial No:	Not Yet Assigned
Filed:	Not Yet Assigned
Title:	APPARATUS AND METHODS FOR CLEANING AND/OR PROCESSING DELICATE PARTS

Assistant Commissioner For Patents
Washington, DC 20231

CERTIFICATE OF MAILING (37 CFR § 1.8(a))
I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Assistant Commissioner For Patents, Washington, D.C. 20231

June 12, 2002 — By Erin Shea

Date of Signature and Mail Deposit. — Erin Shea

PRELIMINARY AMENDMENT

Sir:

Applicant requests that the following amendments be entered and remarks considered:

IN THE SPECIFICATION:

On page 1, please delete lines 5 through 7, and insert:

--This application is a Continuation Application of Divisional Application Serial No. 09/678,576, filed October 3, 2000, which is a divisional application of Continuation-in-Part Application Serial No. 09/066,158, filed April 24, 1998, now U.S. Patent No. 6,181,051 entitled "Apparatus And Methods For Cleaning And/Or Processing Delicate Parts", which is a continuation of U.S. Patent Application Serial No. 08/718,945 filed on September 24, 1996, now U.S. Patent No. 5,834,871, entitled "Apparatus And Methods For Cleaning And/Or Processing Delicate Parts", and U.S. Provisional Patent Application Serial No. 60/023,150, filed on August 5, 1996, each of which is expressly incorporated herein by reference.

The specification attached hereto corresponds to the specification existing in the parent application Serial No. 09/678,576, including amendments to correct the specification.--

Please amend the specification as follows:

Page 14, line 2,	delete "manufacture" and insert --manufacturer--;
Page 41, line 9,	delete "logic 20" and insert --logic 120--; and
Page 41, line 10,	delete "multivibrator 19" and insert --multivibrator 119--.

These amendments update the "Related Applications" information, and correct typographical errors. No new matter has been added.

In the Claims:

Please cancel claims 12-15, 17, 24, 28, and 33-42 without prejudice.

Please amend claims 1, 2, 4, 7, 9, 10, 11, 16, 18, 19, 20, 21, 22, 23, 25, 26, 29, 30 and 31 as shown. Add new claims 43-58. All pending claims 1-11, 16, 18-23, 25-27, 29-32, 43 -58 follow for the convenience of the Examiner.

1. (amended) A system for delivering broadband ultrasound to liquid, comprising:

first and second ultrasonic transducers, each including two or more compressed ceramic elements, the first ultrasonic transducer having a first frequency and a first ultrasound bandwidth, the second ultrasonic transducer having a second frequency and a second ultrasound bandwidth, the first and second bandwidths being overlapping with each other, the first frequency being different from the second frequency; and

ultrasonic generator means for driving the ultrasonic transducers at frequencies within the bandwidths, the first and second ultrasonic transducers and the ultrasonic generator means being constructed and arranged so as to produce ultrasound within the liquid and with a combined bandwidth that is greater than either of the first or second bandwidths.

2. (amended) A system according to claim 1, further comprising a third ultrasonic transducer having a third frequency and a third ultrasound bandwidth, the third bandwidth being overlapping with at least one of the other bandwidths, the third frequency being different from the first and second frequencies, and wherein the ultrasonic generator means comprises means for driving the third ultrasonic transducer within the third bandwidth so as to produce ultrasound within the liquid and with a combined bandwidth that is greater than either of the first, second or third bandwidths.

3. A system according to claim 1, wherein the first frequency is about 40khz and the first bandwidth is about 4.1khz, and wherein the second frequency is about 44khz and the second bandwidth is about 4.2khz, the ultrasound having a combined bandwidth of at least about 8khz.

4. (amended) A system according to claim 1, further comprising clamping means for applying compression to at least one of the ultrasonic transducers.

5. A system according to claim 1, wherein the first and second frequencies are harmonic frequencies.

6. A system according to claim 5, wherein the harmonic frequencies are between about 100khz and 350khz.

7. (amended) A system according to claim 1, further comprising one or more other ultrasonic transducers, each of said other ultrasonic transducers having an additional frequency and an additional ultrasound bandwidth, wherein the additional bandwidths each overlap with at least one other of said bandwidths, and wherein each of the additional frequencies are different from each other and from the first and second frequencies, and wherein the ultrasonic generator means comprises means for driving the additional ultrasonic transducer within the additional bandwidths so as to produce ultrasound within the liquid and with a combined bandwidth that is greater than any other bandwidth.

8. A system according to claim 7, wherein the additional frequency is a harmonic resonant frequency between about 100khz and 350khz.

9. (amended) A system according to claims 1,2, 5, 7 or 8, wherein the bandwidths overlap so that, in combination, the ultrasonic transducers produce ultrasonic energy at substantially all frequencies within the combined bandwidth.

10. (amended) A system according to claims 1,2, 5, 7 or 8, wherein the bandwidths overlap so that the ultrasonic transducers and ultrasonic generator means produce ultrasonic energy, at each frequency, that is within a factor of two of ultrasonic energy produced by the ultrasonic transducers and ultrasonic generator means at any other frequency within the combined bandwidth.

11. (amended) A system according to claims 1,2, 5, 7 or 8, wherein the bandwidths overlap so that the ultrasonic transducers and ultrasonic generator means produce ultrasonic energy, at each frequency, that is substantially equal to the ultrasonic energy produced by the ultrasonic

transducers and ultrasonic generator means at any other frequency within the combined bandwidth.

12. Cancelled.

13. Cancelled.

14. Cancelled.

15. Cancelled.

16. (amended) A system according to claim 1, wherein the ultrasonic generator means comprises two or more ultrasonic generators that are synchronized in magnitude and phase so that there is substantially zero frequency difference between signals generated by the ultrasonic generators.

17. Cancelled.

18. (amended) A system according to claim 16, further comprising FM means for generating a master frequency modulated signal to each ultrasonic generator to synchronize the signals from the ultrasonic generators.

19. (amended) A system according to claim 5, wherein the ultrasonic generator means is frequency modulated over a range of frequencies within the bandwidth of each ultrasonic transducer.

20. (amended) A system according to claim 5, wherein the ultrasonic generator means is frequency modulated over a range of frequencies within the bandwidth of each ultrasonic transducer, and wherein the ultrasonic generator means is amplitude modulated over a range of frequencies within the bandwidth of each ultrasonic transducer.

21. (amended) A system according to claim 1, further comprising a chamber for holding a solution so as to clean or process objects therein.

22. (amended) A system according to claim 21, wherein the chamber comprises a material selected from the group of 316L stainless steel, 304 stainless steel, polytetrafluoroethylene, fluorinated ethylene propylene, polyvinylidine fluoride, perfluoro-alkoxy, polypropylene, tantalum, Teflon coated stainless steel, titanium, hastalloy, polyetheretherketone, and mixtures thereof.

23. (amended) A system according to claim 1, wherein one or more ultrasonic transducer comprises an ultrasonic transducer array.

24. Cancelled

25. (amended) A system according to claim 1, wherein each ultrasonic transducer comprises one of the first, second, third or fourth harmonic frequencies.

26. (amended) A system according to claim 1, further comprising a liquid, the liquid being responsive to the ultrasound to produce cavitation implosion therein.

27. A system according to claim 26, wherein the liquid comprises one or more chemicals selected from the group of solvents, aqueous solutions, and semi-aqueous solutions.

28. Cancelled.

29. (amended) A method of delivering broadband ultrasound to liquid, comprising the steps of driving a first ultrasonic transducer, including two or more compressed ceramic elements, with an ultrasonic generator at a first range of frequencies and within a first ultrasound bandwidth, and driving a second ultrasonic transducer, including two or more compressed ceramic elements, with an ultrasonic generator at a second range of frequencies and within a second ultrasound

bandwidth that overlaps at least part of the first bandwidth, wherein the first and second ultrasonic transducers, in combination with the ultrasonic generator, produce ultrasound within the liquid and with a combined bandwidth that is greater than either of the first or second bandwidths.

30. (amended) A method according to claim 29, further comprising the step of compressing at least one of the ultrasonic transducers.

31. (amended) A method according to claim 29, further comprising the step of driving the first and second ultrasonic transducers at harmonic frequencies between about 100khz and 350khz.

32. A method according to claim 29, further comprising the step of arranging the bandwidths to overlap so as to produce ultrasonic energy, at each frequency, that is within a factor of two of ultrasonic energy produced at any other frequency within the combined bandwidth.

43. (New) A system for delivering ultrasonic energy to a liquid, comprising:

A. two or more ultrasonic transducers adapted for coupling to said liquid, wherein

(i) each ultrasonic transducer is capable of producing ultrasonic energy in said liquid at two or more resonant frequencies, each resonant frequency being within a range of frequencies associated with that resonant frequency, and

(ii) the two or more ultrasonic transducers are electrically coupled;

B. two or more ultrasonic generators, each ultrasonic generator being adapted for producing a drive signal within one of the ranges of frequencies associated with one of the two or more resonant frequencies;

C. a multiplexer for receiving the drive signals from the two or more ultrasonic generators and for electrically coupling the received drive signals, one at a time in a time sequence, to the electrically coupled two or more ultrasonic transducers; and

D. a controller for controlling the multiplexer in a first state, so that one of the two or more ultrasonic generators drives the coupled two or more ultrasonic transducers to produce ultrasonic energy in said liquid characterized by a frequency that sweeps across one of the frequency ranges, and

in a second state, so that another of the two or more ultrasonic generators drives the coupled two or more ultrasonic transducers to change frequency to a different frequency range, to produce ultrasonic energy in said liquid characterized by a frequency that sweeps across at least another of the frequency ranges.

44. (New) A system according to claim 43, wherein each of the two or more ultrasonic transducers is capable of producing the same two or more resonant frequencies as all of the other two or more ultrasonic transducers.

45. (New) A system according to claim 43, wherein the two or more resonant frequencies include a fundamental frequency and one or more harmonic frequencies.

46. (New) A system according to claim 43, wherein the two or more resonant frequencies includes a first frequency of about 40khz, a second frequency of about 72khz, and a third frequency of about 104khz.

47. (New) A system according to claim 43, wherein at least one of the two or more ultrasonic generators further produces a drive signal characterized by a frequency that sweeps, at a first sweep rate, within one of the ranges of frequencies associated with one of the two or more resonant frequencies.

48. (New) A system according to claim 47, wherein the ultrasonic generator further sweeps the first sweep rate at a second sweep rate.

49. (New) A system according to claim 43, wherein the controller controls the multiplexer to one of the first state or second state as a predetermined function of a particular chemistry of the liquid.

50. (New) A system according to claim 43, further including clamping means for applying compression to at least one of the two or more ultrasonic transducers.

51. (New) A system for delivering ultrasonic energy to a liquid, comprising:

A. two or more ultrasonic transducers adapted for coupling to said liquid, wherein

(i) each ultrasonic transducer is capable of producing ultrasonic energy in said liquid at two or more resonant frequencies, each resonant frequency being within a range of frequencies associated with that resonant frequency, and

(ii) the two or more ultrasonic transducers are electrically coupled to a common input;

B. two or more ultrasonic generators, each ultrasonic generator being adapted for producing a drive signal within one of the ranges of frequencies associated with one of the two or more resonant frequencies;

C. a multiplexer having at least two states, for receiving the drive signals from the two or more ultrasonic generators and in response to an applied control signal, for electrically coupling the received drive signals, one at a time in a time sequence, to the common input of the electrically coupled two or more ultrasonic transducers; and

D. a controller for generating the control signal and applying the control signal to the multiplexer so that

(i) in a first state, the drive signal from one of the two or more ultrasonic generators drives the coupled two or more ultrasonic transducers to produce ultrasonic energy in said liquid characterized by a frequency that sweeps across one of the frequency ranges, and (ii) in a second state, the drive signal from another of the two or more ultrasonic generators drives the coupled two or more ultrasonic transducers to change frequency to a different frequency range, to produce ultrasonic energy in said liquid characterized by a frequency that sweeps across another of the frequency ranges.

52. (New) A system according to claim 51, wherein each of the two or more ultrasonic transducers is capable of producing the same two or more resonant frequencies as all of the other two or more ultrasonic transducers.

53. (New) A system according to claim 51, wherein the two or more resonant frequencies include a fundamental frequency and one or more harmonic frequencies.

54. (New) A system according to claim 51, wherein the two or more resonant frequencies includes a first frequency of about 40khz, a second frequency of about 72khz, and a third frequency of about 104khz.

55. (New) A system according to claim 51, wherein at least one of the two or more ultrasonic generators further produces a drive signal characterized by a frequency that sweeps, at a first sweep rate, within one of the ranges of frequencies associated with one of the two or more resonant frequencies.

56. (New) A system according to claim 55, wherein the ultrasonic generator further sweeps the first sweep rate at a second sweep rate.

57. (New) A system according to claim 51, wherein the controller controls the multiplexer to one of the first state or second state as a predetermined function of a particular chemistry of the liquid.

58. (New) A system according to claim 51, further including clamping means for applying compression to at least one of the two or more ultrasonic transducers.

REMARKS

By this amendment claims 1-11, 16, 18-23, 25-27, 29-32, 43-58 remain pending for consideration. Claims 12-15, 17, 24, 28 and 33-42 have been canceled without prejudice.

In the May 14, 2001 Office Action of the parent application (09/678,576), the Examiner rejected claims 1, 2, 7, 23, 26, 27 and 29 under 35 U.S.C. 102(a) as being anticipated by Massa. Accordingly, the Applicant has amended claims 1 and 29 to include the following limitation: each ultrasonic transducer includes two or more compressed ceramic elements. Support for this limitation may be found in the specification at page 36, lines 11-17. Massa teaches a transducer array that includes a coaxial alignment of a plurality of cylindrical transducer elements (column 1, lines 46-56). Massa does not teach or suggest individual ultrasonic transducer elements that include two or more compressed ceramic elements. Using two or more compressed ceramic elements is particularly advantageous for three reasons. First, an ultrasonic transducer with a single ceramic element requires an insulator to provide electrical insulation from the mounting bolt. A ultrasonic transducer with two or more ceramic elements does not require such an insulator, because the common polarity contacts of the two elements can be arranged to face one another, so that the electrical lead-in for that polarity contact comes from between the ceramic elements. Second, a given amount of ultrasonic energy that is distributed over two or more elements reduces the stress on any one element, i.e., with respect to the same amount of energy originating from a single element. Third, using two or more ceramic elements reduces the voltage needed to drive the ultrasonic transducer. For example, with two ceramic elements, the drive voltage necessary is 0.707 of the voltage required to drive a single ceramic element. Thus, having two or more compressed ceramic elements in each ultrasonic transducer is a useful

limitation that Massa does not teach or suggest. There is no longer a basis for the rejection of claims 1 and 29 as amended; that rejection should be withdrawn. Since claims 2, 7, 23, 26 and 27 depend from claim 1 (as amended), the rejection to those claims should also be withdrawn.

Also in the May 14, 2001 Office Action of the parent application (09/678,576), the Examiner rejected claims 4-6, 8-11, 25 and 30-32 under 35 U.S.C. 103(a) as being unpatentable over Massa. Since claims 4-6, 3-11 and 25 depend from allowable claim 1 (as amended), those claims should also be allowable and that rejection should be withdrawn.

Also in the May 14, 2001 Office Action of the parent application (09/678,576), the Examiner rejected claims 16 and 18-20 under the judicially created doctrine of obviousness type double patenting as being unpatentable over claims 1-21 of U.S. Patent No. 6,181,051 in view of Massa. Since claims 16 and 18-20 depend from now allowable base claim 1 (as amended), there is no longer a basis for that rejection, and that rejection should be withdrawn.

Also in the May 14, 2001 Office Action of the parent application (09/678,576), the Examiner rejected claims 21, 22, 26 and 27 under 35 U.S.C. 103(a) as being unpatentable over Shiro, Cook or Mettler in view of Massa. Since claims 21, 22, 26 and 27 depend from now allowable base claim 1 (as amended), there is no longer a basis for that rejection, and that rejection should be withdrawn.

New claims 43 - 58 have been added to more completely and clearly describe the invention.

No additional costs are believed to be due in connection with the filing of this Amendment. However, should any fees be due, please charge our Deposit Account No. 50-1133. A copy of this page is enclosed for this purpose.

If the Examiner believes there are any outstanding issues to be resolved with respect to the above-identified application, he is invited to telephone the undersigned at his earliest convenience so that such issues may be resolved telephonically.

Respectfully submitted,

Date: June 12, 2002

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Version with markings to show changes made

1. (amended) A system for delivering broadband ultrasound to liquid, comprising:

first and second ultrasonic transducers, each including two or more compressed ceramic elements, the first ultrasonic transducer having a first frequency and a first ultrasound bandwidth, the second ultrasonic transducer having a second frequency and a second ultrasound bandwidth, the first and second bandwidths being overlapping with each other, the first frequency being different from the second frequency; and

[ultrasound] ultrasonic generator means for driving the ultrasonic transducers at frequencies within the bandwidths, the first and second ultrasonic transducers and the ultrasonic generator means being constructed and arranged so as to produce ultrasound within the liquid and with a combined bandwidth that is greater than either of the first or second bandwidths.

2. (amended) A system according to claim 1, further comprising a third ultrasonic transducer having a third frequency and a third ultrasound bandwidth, the third bandwidth being overlapping with at least one of the other bandwidths, the third frequency being different from the first and second frequencies, and wherein the ultrasonic generator means comprises means for driving the third ultrasonic transducer within the third bandwidth so as to produce ultrasound within the liquid and with a combined bandwidth that is greater than either of the first, second or third bandwidths.

4. (amended) A system according to claim 1, further comprising clamping means for applying compression to at least one of the ultrasonic transducers.

7. (amended) A system according to claim 1, further comprising one or more [at least one] other ultrasonic transducers, each of said other ultrasonic transducers having an additional frequency and an additional ultrasound bandwidth, wherein the additional bandwidths [being overlapping] each overlap with at least one other of said bandwidths, and wherein each of the

additional [frequency being] frequencies are different from each other and from the first and second frequencies, and wherein the ultrasonic generator means comprises means for driving the additional ultrasonic transducer within the additional bandwidths so as to produce ultrasound within the liquid and with a combined bandwidth that is greater than any other bandwidth.

9. (amended) A system according to claims 1,2, 5, 7 or 8, wherein the bandwidths overlap so that, in combination, the ultrasonic transducers produce ultrasonic energy at substantially all frequencies within the combined bandwidth.

10. (amended) A system according to claims 1,2, 5, 7 or 8, wherein the bandwidths overlap so that the ultrasonic transducers and ultrasonic generator means produce ultrasonic energy, at each frequency, that is within a factor of two of ultrasonic energy produced by the ultrasonic transducers and ultrasonic generator means at any other frequency within the combined bandwidth.

11. (amended) A system according to claims 1,2, 5, 7 or 8, wherein the bandwidths overlap so that the ultrasonic transducers and ultrasonic generator means produce ultrasonic energy, at each frequency, that is substantially equal to the ultrasonic energy produced by the ultrasonic transducers and ultrasonic generator means at any other frequency within the combined bandwidth.

16. (amended) A system according to claim[s] 1 [or 12], wherein the ultrasonic generator means comprises two or more [ultrasound] ultrasonic generators that are synchronized in magnitude and phase so that there is substantially zero frequency difference between signals generated by the ultrasonic generators.

18. (amended) A system according to claim 16, further comprising FM means for generating a master frequency modulated signal to each ultrasonic generator to synchronize the signals from the ultrasonic generators.

19. (amended) A system according to claim 5, wherein the ultrasonic generator means is frequency modulated over a range of frequencies within the bandwidth of each ultrasonic transducer.

20. (amended) A system according to claim 5, wherein the ultrasonic generator means is frequency modulated over a range of frequencies within the bandwidth of each ultrasonic transducer, and wherein the ultrasonic generator means is amplitude modulated over a range of frequencies within the bandwidth of each ultrasonic transducer.

21. (amended) A system according to claim[s] 1 [or 12], further comprising a chamber for holding [the] a solution so as to clean or process objects therein.

22. (amended) A system according to claim 21, wherein the chamber comprises a material selected from the group of 316L stainless steel, 304 stainless steel, polytetrafluoroethylene, fluorinated ethylene propylene, polyvinylidine fluoride, perfluoro-alkoxy, polypropylene, tantalum, [teflon] Teflon coated stainless steel, titanium, hastalloy, polyetheretherketone, and mixtures thereof.

23. (amended) A system according to claim[s] 1 [or 12], wherein one or more ultrasonic transducer comprises an ultrasonic transducer array.

25. (amended) A system according to claim[s] 1 [or 12], wherein each ultrasonic transducer comprises one of the first, second, third or fourth harmonic[s] frequencies.

26. (amended) A system according to claim[s] 1 [or 12], further comprising a liquid, the liquid being responsive to the ultrasound to produce cavitation implosion therein.

29. (amended) A method of delivering broadband ultrasound to liquid, comprising the steps of driving a first [ultrasound] ultrasonic transducer, including two or more compressed ceramic

elements, with an ultrasonic generator at a first range of frequencies [frequency] and within a first ultrasound bandwidth, and driving a second [ultrasound] ultrasonic transducer, including two or more compressed ceramic elements, with an ultrasonic generator at a second range of frequencies [frequency] and within a second ultrasound bandwidth that overlaps at least part of the first bandwidth, wherein the first and second ultrasonic transducers, in combination with the ultrasonic generator, produce ultrasound within the liquid and with a combined bandwidth that is greater than either of the first or second bandwidths.

30. (amended) A method according to claim 29, further comprising the step of compressing at least one of the ultrasonic transducers.

31. (amended) A method according to claim 29, further comprising the step of driving the first and second ultrasonic transducers at harmonic frequencies between about 100khz and 350khz.